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INCREASING RETURNS, TRADE AND THE REGIONAL STRUCTURE OF WAGES*

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Trade theories based on increasing returns have two predictions for regional economies: employment concentrates in industry centres, and regional nominal wages are decreasing in transport costs to industry centres. I test these hypotheses using data on regional manufacturing in Mexico before and after trade liberalisation. Employment and wage patterns are consistent with the idea that market access matters for industry location. Under the closed economy, industry concentrated in Mexico City. Since trade reform, industry has relocated to the United States–Mexico border. Estimation results show that regional manufacturing wages are decreasing in distance from Mexico City and from the border.

The link between industrialisation and agglomeration has long been recognised by economists. The development theories of Myrdal (1957) and Hirschman (1958) identify a fundamental interdependence between industrial growth and the geographic concentration of industry: industrialisation collects human and capital resources in a given location and the resulting agglomeration sustains the conditions for further growth. Recent literature on economic geography formalises such cumulative processes in models based on increasing returns to scale (Fujita, 1988; Krugman, 1991).

The present work tests for increasing returns-based agglomeration by exploiting information contained in the regional structure of wages. The implications of increasing returns for regional wage gradients have been underemphasised. Consider the model in Krugman (1991). Agglomeration results from pecuniary externalities associated with increasing returns and transport costs: firms that locate in densely populated regions economise on fixed costs, by concentrating production in a single plant, and on transport costs, by locating near a large market. To the extent agglomeration creates congestion costs, firms in agglomerated regions must compensate workers by paying them high wages relative to outlying areas (Krugman and Livas, 1992). The theory has two predictions: (1) industry concentrates geographically, and (2) relative wages decrease with transport costs from industrial centres. Using data from Mexico, I document conditions consistent with the first prediction and formally test the second prediction.

Empirically identifying agglomeration effects has proven to be a difficult task. Agglomeration due to static increasing returns is observationally equivalent to agglomeration due to exogenous site-specific characteristics.[1] A standard approach in the empirical literature is to identify agglomeration

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[1] In this paper, I focus on the static agglomeration economies that are the basis of recent trade theory. For empirical evidence of dynamic externalities, see Glaeser *et al.* (1992), Jaffe *et al.* (1993), Rauch (1993), and Henderson (1994).

effects by using a measure of local industrial activity, such as value added or employment, as an independent variable. Carlton (1983) finds agglomeration makes a location more attractive to entering firms, Nakamura (1985) and Henderson (1986) find agglomeration is positively correlated with total factor productivity, and Wheeler and Mody (1992) find the local stock of foreign investment is a positive factor in the location decision of United States multinationals. These findings are interpreted as evidence of agglomeration effects, but it is just as plausible to interpret them as evidence of unobserved fixed factors that firms value.

The approach of this paper takes advantage of the implications that increasing returns have for the structure of regional wages. Other forces can generate agglomeration, but few are likely to generate the same regional wage gradients as do increasing returns. Regional variation in resource endowments and exogenous amenities are two sources of wage differentials that have been studied extensively in the literature (Roback, 1982, 1988; Beeson, 1991).[2] Hedonic estimation of wages and land rents find that both endowment and amenity effects contribute to regional wage and rent differentials (Beeson and Eberts, 1989; Gyourko and Tracy, 1991). Exogenous site-specific characteristics surely matter for wages, but only with low probability will they cause wages to decrease with distance from industry centres. The contribution of this paper is to consider the economy-wide wage structure. The test of increasing returns-based agglomeration I propose requires not just that wages are positively correlated with agglomeration, but that wages decrease monotonically as one moves away from industry centres.[3]

A history of abrupt changes in trade policy makes Mexico a natural case in which to study industry agglomeration. Mexico's industrial growth began in the 1940s, when the government imposed high trade barriers as part of a strategy of import-substitution industrialisation (ISI). In the 1980s the government reversed its policy and opened the economy to foreign trade and investment. Mexico's regional employment patterns are consistent with increasing returns to scale. During ISI, industry concentrated in Mexico City; at its height, the capital contained 45% of the country's manufacturing labour force. High trade barriers made it feasible for the country to develop an industrial centre. Mexico City was where industry began to concentrate; the logic of increasing returns implied that, once established, agglomeration would persist. Since the opening to trade, industrial activity has shifted to the United States–Mexico border region. For Mexico, the size and proximity of the United States make trade liberalisation tantamount to integration with its northern

[2] One problem with the approach in this literature is that it treats amenities as exogenous. This implies land prices in Manhattan are high relative to other areas due not to the city's collection of restaurants, theatres, shops, and museums (whose location is endogenous), but to local weather, water quality, and other exogenous features.

[3] Consider the case of Mexico City, the principal industry centre in Mexico. The test I employ requires that wages decline not just as a worker moves from the centre of the capital to the suburbs, but as a worker moves from the southern state of Oaxaca to the more distant southern state of Chiapas.

neighbour. Trade reform has weakened the pull of the closed-economy industry centre in Mexico City and strengthened the pull of the United States market.

I examine the link between proximity to industry centres and regional wages by estimating Mexico's pre- and post-trade reform regional wage structure. The theory of increasing returns-based agglomeration predicts that (1) nominal wages decrease from Mexico City and from the United States, and (2) a reduction of trade barriers compresses regional wage differentials. The empirical results show support for both hypotheses. While these findings are consistent with both increasing returns to scale in production and location bias in government policy, they support the general idea that market access – in the form of transport costs to industry centres – matters for regional wage patterns.

More broadly, the results of this paper suggest that trade policy plays an important role in regional development. The rise of a dominant industrial centre – a phenomenon general to many developing countries – appears to be a byproduct of import substitution. Trade liberalisation contributes to a spatial deconcentration of economic activity, as firms shift from production for the domestic market to production for foreign markets. While trade diminishes regional disparities in employment and wages, the result is not the transition to an 'even' pattern of regional development. Trade shifts employment to regions near foreign markets, helping create new, though perhaps less extreme, regional differences.

The body of the paper contains four sections. Section I outlines the theoretical predictions for regional wages; Section II describes employment and wage patterns in Mexico; Section III gives empirical results; and a final section concludes.

I. THEORY

I.A. *Increasing Returns and Industry Agglomeration*

This section outlines the predictions of the increasing-returns theory of agglomeration for regional wage differentials. A common theme that unifies the theory is a tension between agglomeration economies and congestion costs. The literature remains divided, however, over the source of agglomeration economies.

In the most recent strand of literature, agglomeration economies result from the interaction of fixed production costs and transport costs (Fujita, 1988; Krugman, 1991; Krugman and Livas, 1992; Asilis and Rivera-Batiz, 1993). The basic model is one that is familiar from trade theory, extended to a multi-region setting. There are a large number of differentiated products, each of which is produced under increasing returns to scale. Preferences are of the Dixit and Stiglitz (1977) type. In equilibrium, each good is produced by a single, monopolistically-competitive firm. Fixed production costs imply firms prefer, all else equal, to serve consumers from a single location; transport costs imply firms prefer, all else equal, to locate near large markets. The circularity of these effects creates an industry centre: a large market forms wherever firms happen

to locate. Once firms are agglomerated in an industry centre, subsequent entrants also prefer the industry centre to alternative locations since it offers the least-cost site from which to serve the broader market. Similar results obtain if there are increasing returns in the production of non-traded inputs (Rivera-Batiz, 1988).

In an earlier strand of literature, agglomeration economies arise from non-pecuniary location-specific externalities (Henderson, 1974, 1982; Rauch, 1989, 1991). Production at the firm level exhibits constant returns to scale and all industries are perfectly competitive. The agglomeration of economic activity generates external effects that enhance the productivity of all firms that share a given geographic location. While the precise source of such externalities is rarely made explicit, the familiar story is that the dense concentration of firms facilitates learning and other types of knowledge spillovers. The existence of location-specific externalities implies that firms prefer to locate near large concentrations of other firms.

Both types of agglomeration economies give rise to the formation of industry centres. While the mircofoundations of the two bodies of theory differ, they share an emphasis on increasing returns to scale, at some level, as to the cause of agglomeration. Rather than try to identify the precise nature of the scale economies that are at work, the approach I take is to distinguish the predictions of agglomeration due to increasing returns from agglomeration due to purely exogenous factors. I motivate the empirical methodology in terms of the Fujita–Krugman model, but a comparable motivation can be made in terms of the Henderson model.

Whether increasing returns are internal or external to firms, the logical consequence of agglomeration economies is the geographic concentration of economic activity in a single location. The force working against such an outcome is congestion costs. The agglomeration of economic activity requires workers to live in a confined geographic area, which drives up land rents or increases congestion-related disamenities in the industry centre relative to outlying locations. To attract workers to the industry centre firms must compensate workers for congestion costs by paying them relatively high wages. Conversely, firms in outlying regions pay workers relatively low wages to compensate for the fact that they must transport their output to the industry centre; workers accept lower wages given that they face lower congestion costs.

For sufficiently strong agglomeration economies, it is an equilibrium outcome for firms to concentrate in one or more industry centres. Nominal wages are then decreasing in transport costs to industry centres. The implications for land rents, however, are ambiguous. In industry centres high housing demand tends to make land rents relatively high, but high levels of pollution and other disamenities work in the opposite direction. In the absence of clear implications for land rents, I focus on the implications of agglomeration for regional wage differentials.

Where industry agglomerates depends on a country's trading position with the rest of the world. Consider first the case of a closed economy. To motivate

the analysis, I use Mexico as an example. Suppose conditions in Mexico are such that industry agglomerates in a single industry centre. The location firms happen to choose is Mexico City. The predictions of the model for regional relative wages can be summarised in the following reduced-form equation:

$$\frac{w_i}{w_c} = F(x_i, x_i^*), \tag{1}$$

for which it holds that

$$w_c \geqslant w_i, \quad i \neq c, \quad \text{and} \quad \frac{\partial \frac{w_i}{w_c}}{\partial x_i} < 0, \tag{3}$$

where w_i is the nominal wage in location i, w_c is the nominal wage in the industry centre, and x_i is unit transport costs from location i to the industry centre. The function $F(\ )$ embodies preferences and technology; it is conditional on location c being an industry centre. An equilibrium relationship identical to (1)–(3) is derived in Krugman and Livas (1992). Similar results are obtained in Henderson (1982), Rivera-Batiz (1988), and Rauch (1989, 1991).

Now consider the case in which trade barriers are not prohibitive, such that firms produce for domestic and foreign markets. All else equal, transport costs imply exporters will locate in regions with relatively low-cost access to the foreign market. For Mexico, proximity to foreign markets means proximity to the United States. Given trade barriers that are large, but not too large, there will be two types of industry centres: a principal centre in Mexico City, in which firms produce for the domestic market, and smaller centres near the United States–Mexico border, in which firms produce for the foreign market. The possibility of producing for two markets implies regional relative wages will also reflect transport costs to the foreign market, or that

$$\frac{\partial \frac{w_i}{w_c}}{\partial x_i^*} < 0, \tag{4}$$

where x_i^* is unit transport costs from location i to the foreign market.

Suppose Mexico enacts trade reform, which I assume takes the form of a bilateral reduction in trade barriers in Mexico and the rest of the world. Trade liberalisation increases foreign demand relative to domestic demand, weakening the lure of the domestic industry centre in Mexico City. To improve access to the foreign market, firms relocate from Mexico City to the United States border. The exodus of firms from the domestic industry centre causes a spatial deconcentration of employment. As firms leave Mexico City, congestion costs fall, which reduces nominal wages in Mexico City relative to nominal wages in outlying locations. The transition to an open economy causes a compression of regional wage differentials.

The discussion in this section suggests a simple econometric approach to test for the effect of increasing returns-based agglomeration on regional relative

wages. Combining equations (1) to (4), I specify the following reduced-form, log-linear regression equation:

$$\ln\left(\frac{w_{it}}{w_{ct}}\right) = \beta_0 + \beta_1 \ln(x_{it}) + \beta_2 \ln(x_{it}^*) + \epsilon_{it}, \tag{5}$$

where i indexes geographic location, t indexes time, c indexes the closed-economy industry centre, ϵ_{it} is an error term, and the preceding variable definitions apply. Given that under the closed economy an industry centre forms in location c, the predictions are that (1) the regression coefficients β_1 and β_2 are negative, and (2) in the transition to an open economy there is a structural break in this relationship, which reduces the effect of transport costs to the domestic industry centre ($|\beta_1|$) on regional relative wages.

I.B. *Other Sources of Regional Wage Differentials*

The exogenous characteristics of regions may also generate regional wage gradients. If one region contains an abundant water supply or large deposits of a mineral, then industries intensive in the use of such resources will concentrate nearby. If transport costs are positive, firms in footlose industries – industries intensive in the use of mobile resources – will also prefer to locate near the natural-resource concentration in order to serve the market created by the agglomeration of natural-resource-intensive industries. Firms that locate near resource concentrations will be willing to compensate workers for congestion costs in the form of higher wages since, by virtue of their location, they have lower transport costs.

Regions also vary in the exogenous amenities they offer consumers. Some locations may be attractive places to live and work because they have nice beaches or good weather. To the extent workers value such amenities, they will, all else equal, be willing to accept lower wages in high-amenity locations, as in Roback (1982). In principle, then, a lumpy spatial allocation of natural resources, broadly defined, can generate predictions similar to those in equations (2) and (3). The effects of natural-resource endowments can be incorporated into equation (5) by including fixed location effects, or intercept terms that vary across regions, into the estimation.

Government policy may also affect the relative attractiveness of regions as production sites. The concentration of government activities in a particular region may create a consumption mass that, given transport costs, will attract firms that wish to serve the local market. If the concentration of government activities is sufficiently large, local wages will be bid up and a regional wage gradient will emerge. Additionally, if the government chooses to explicitly (through taxes) or implicitly (through favours) subsidise producers in a particular location, firms will be attracted to the region, driving up local wages and creating regional wage differentials. Agglomeration due to location bias in government policy is indistinguishable from that due to increasing returns. Policy-induced agglomeration, however, should in principle be more resistant to changes in the trade regime than increasing returns-based agglomeration.

While I wish to control for exogenous amenities and disamenities, I explicitly

make no attempt to control for endogenous amenities and disamenities. Such factors are a direct result of agglomeration, and hence an implication of theory. Disamenities due to agglomeration, such as pollution, are consistent with the Fujita–Krugman model. Amenities due to agglomeration, such as a large variety of ethnic restaurants, are inconsistent with the Fujita–Krugman model, but they have the opposite implications for regional wage differentials. Matsuyama and Takahashi (1993) model geographic concentration as a result of increasing returns in the production of non-traded consumer goods. Agglomeration expands the range of non-traded goods produced, attracting consumers to the region. This implies relative wages will be *lower* in agglomerated regions, given workers have access to a relatively abundant array of non-traded goods.

II. REGIONAL EMPLOYMENT AND WAGES IN MEXICO

Regional industrial development in Mexico is consistent with the theory of agglomeration based on increasing returns. Under the closed economy, manufacturing employment concentrated in a single region, Mexico City. Wages were highest in regions proximate to the capital or to the United States. Since the opening to trade, employment has shifted from the capital to the United States–Mexico border region, and regional wage differentials have narrowed.

II.A. *Mexican Policy on Foreign Trade and Investment*

Prior to the 1940s, Mexico had a relatively open economy and was specialised in primary-commodity production (Reynolds, 1970). Mexico's major industrial expansion, which began in the 1940s, was oriented towards production for the domestic economy. Between 1930 and 1970, the manufacturing share of GDP increased from 12·9% to 23·3%. The country experienced a *de facto* process of import-substitution industrialisation in the 1930s and 1940s, as economic depression and world war limited the supply of manufacturing goods from industrialised countries. The government initiated a conscious policy of trade protection in 1947, when it raised tariffs and instituted a system of import licenses. Successive administrations increased the range of goods covered by import licenses and introduced export controls.

Mexico abruptly ended its experience as a closed economy in 1985, when the government announced plans to join the General Agreement on Trade and Tariffs. Trade reform was not widely anticipated, due to failures in carrying out earlier promises of reform and the swiftness with which reform was enacted. In June 1985, import licenses covered 92·2% of national production and the average tariff was 23·5%. By December 1987, the government had abolished export controls, reduced import-licence coverage to 25·4% of production, and cut the average tariff to 11·8%. Table 1 shows average tariffs and shares of production covered by import licences by two-digit (ISIC) industry over the reform period. In 1984, the average tariff was over 29·0% in all industries, except non-metallic minerals, and import licences were required for over

Table 1

Trade Protection in Mexico, 1984–90

Industry (ISIC)	1984	1985	1986	1987	1988	1989	1990
Food products							
t	42·9	45·4	32·1	22·9	14·8	15·8	16·2
q	100·0	80·1	62·2	33·3	20·8	20·6	16·8
Textiles, apparel							
t	38·6	43·2	40·4	26·6	16·8	16·6	16·7
q	92·9	66·8	38·0	31·1	2·8	1·1	1·0
Wood products							
t	47·3	48·5	44·9	29·9	17·7	17·6	17·8
q	100·0	75·6	25·7	0·0	0·0	0·0	0·0
Paper, printing							
t	33·7	36·5	34·8	23·7	7·7	10·1	9·9
q	96·7	54·1	11·2	9·5	3·4	4·1	0·0
Chemicals							
t	29·1	29·9	27·0	20·5	13·4	14·3	14·4
q	85·7	54·0	21·1	4·8	0·0	0·0	0·0
Non-metallic minerals							
t	13·6	16·7	18·4	13·8	7·9	11·0	11·0
q	93·3	47·4	0·0	0·0	0·0	0·0	0·0
Basic metals							
t	37·1	38·5	33·8	22·4	13·8	14·3	14·3
q	99·0	53·1	5·2	0·0	0·0	0·0	0·0
Metal products							
t	43·1	46·3	30·0	20·8	14·1	15·9	16·1
q	90·7	74·8	54·7	51·4	42·7	44·1	44·1
Other Industries							
t	40·9	42·9	40·5	27·5	17·1	18·1	18·4
q	100·0	50·0	0·0	0·0	0·0	0·0	0·0

t = Production-weighted-average tariff rate. *q* = Production-weighted-average share of production subject to import-license requirements.

Source: Unpublished data, Mexican Ministry of Trade and Industrial Promotion.

85·0% of goods produced in all industries. By 1988, the maximum tariff rate in any industry was 17·7%, and import licences covered less than 4·0% of production in all industries, except food products and metal products.

While trade reform represented a wholesale rejection of ISI, it was not the government's first experiment with free-trade policies. In 1965, the government launched the Border Industrialisation Program, which permitted the creation of foreign in-bond assembly plants, known as *maquiladoras*, in spatial enterprise zones along the United States–Mexico border. Plants in the zones were exempt from import duties and restrictions on foreign ownership, as long as they exported all of their output (Hansen, 1981). Maquiladora employment began to expand rapidly after the onset of the Mexican debt crisis in 1982, when the government eliminated many bureaucratic controls governing the plants (Schoepfle and Perez-Lopez, 1990). Maquiladoras have become the primary vehicle through which foreign direct investment enters Mexico and through which manufacturing exports leave Mexico. As such, the maquiladora programme should be considered as the first stage of Mexico's liberalisation efforts.

Fig. 1.

II.B. *Employment and Wages Before and After Trade Reform*

The rise of Mexico City as an industrial centre coincided with the advent of import substitution. Table 2 shows Mexico City's share of national manufacturing employment by two-digit industry from 1930 to 1988. The capital's share of national manufacturing employment rose from 19·0% in 1930 to 24·7% in 1940, during the period of passive ISI, and from 25·0% in 1950 to 46·0% in 1960, during the beginning of active ISI. As dramatic as was the overall increase in agglomeration, industry-level changes were even more striking. The largest increases occurred in relatively footloose industries (textiles, paper, chemicals, and metal products), while the smallest increases occurred in industries that produce a large share of non-traded goods (food products and non-metallic minerals) and natural-resource-intensive goods (basic metals).

The creation of the Mexico City metropolis followed industrialisation, not the reverse. The Federal District, the federal entity that contains the capital, had only 4·0% of Mexico's population in 1900 and 7·9% in 1930. By 1960, after three decades of industrialisation, the Federal District's population share was 14·0%. Mexico City's role as the country's political capital made it a natural site to become an industrial centre. An additional factor was that the capital lay at the heart of the country's railroad network, allowing firms locating in Mexico City to access the country's major markets (Garza, 1985).

Kandell (1988) observes that while natural resources may explain why the Valley of Mexico, which the capital occupies, was originally settled, they do not

account for Mexico City's modern growth. Given its geography, the city has long suffered from chronic water supply and drainage problems and, more recently, from severe air pollution. Further, Mexico's major natural-resource endowments, crude oil and mineral deposits, are located far from the capital, in southern states on the Gulf of Mexico and in northern desert states.

The Mexico *Industrial Census* provides further evidence at the state level, which I summarise by grouping states into five regions (see Fig. 1). Until 1980, employment was concentrated in states surrounding Mexico City. This is seen in Fig. 2, which shows the regional distribution of manufacturing employment

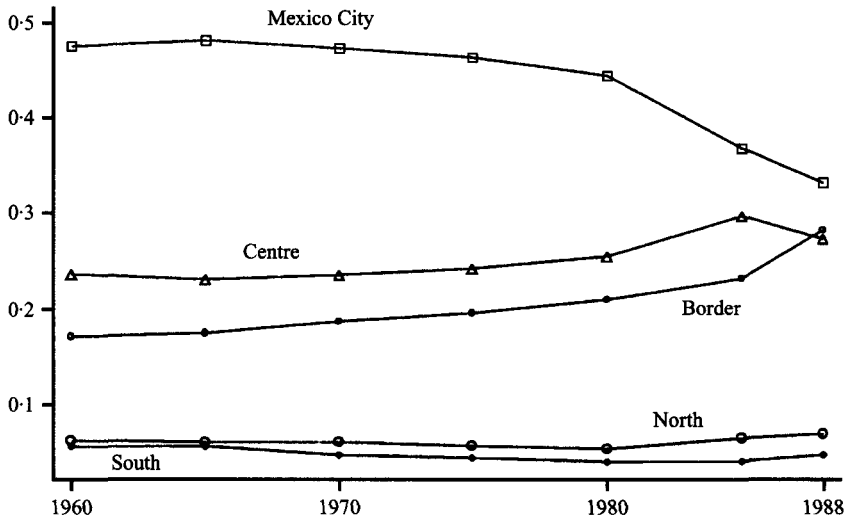

Fig. 2. Regional shares of manufacturing employment.

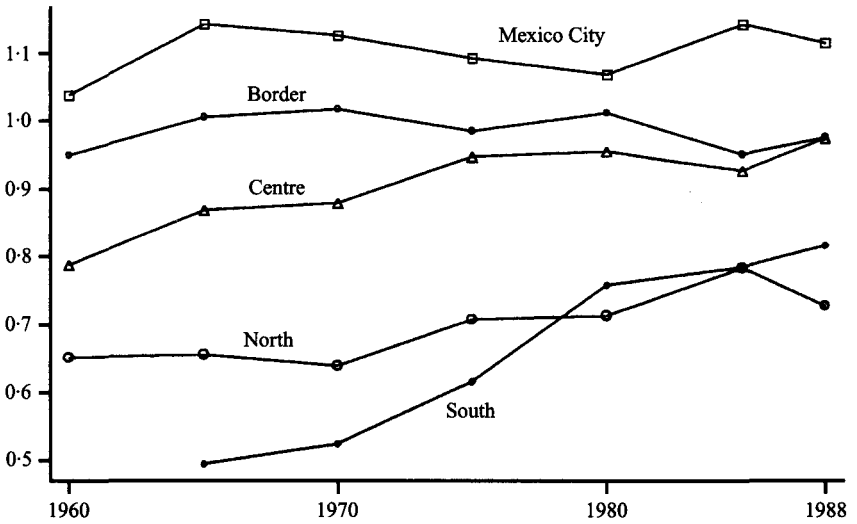

Fig. 3. Regional average wage/national average wage.

from 1960 to 1988. In 1980, the Mexico City region contained 44·4% of national manufacturing employment. When the Centre is added in, centrally-located states contained 69·9% of manufacturing employment. The North and South, which are contiguous neither to the capital nor to the United States, are Mexico's periphery; the two regions combined, which account for 40·5% of Mexico's land area, contained only 9·2% of national manufacturing employment. The Border's manufacturing share, due largely to the presence of the maquiladora industry, was 21·0%.

Regional relative wages mirror industry location patterns. Fig. 3 plots the regional average nominal manufacturing wage relative to the national average nominal manufacturing wage from 1960 to 1988. Over the period, Mexico City had the highest wages, followed by the Border and the Centre, with the North and South lagging far behind. In 1965, the year wage differentials were at their peak, the Mexico City average wage was 1·14 times the Border wage, 1·32 times the Centre wage, 1·75 times the North wage, and 2·31 times the South wage.

Table 2

Regional Employment Shares By Two-Digit Industry (%), *1930–88*

	Mexico City								Border States		
Industry (ISIC)	1930	1940	1950	1960	1970	1980	1985	1988	1980	1985	1988
All manufacturing	19·0	24·7	25·0	46·0	41·9	44·4	36·8	33·2	21·0	23·2	28·2
Food products	8·7	12·3	26·0	26·7	22·8	28·7	26·6	25·6	17·7	18·9	18·5
Textile, apparel	20·0	23·8	19·9	48·1	51·4	43·9	36·9	33·6	11·3	12·7	18·0
Wood products	28·3	34·6	31·0	39·6	36·4	36·9	29·0	20·6	19·2	23·8	25·7
Paper, printing	37·1	35·9	33·6	57·5	52·6	65·1	57·6	54·3	13·9	16·0	19·0
Chemicals	44·4	53·8	47·0	69·7	60·0	55·7	43·6	45·6	14·6	14·4	16·6
Non-metallic minerals	23·1	27·5	17·4	38·8	33·0	29·8	29·2	29·1	49·2	40·4	40·1
Basic metals	0·0	14·1	0·2	24·3	21·2	34·6	28·3	26·1	32·1	28·6	31·8
Metal products	26·1	39·2	23·3	63·6	52·2	50·7	39·9	32·0	26·9	34·3	46·0
Other industries	36·8	89·6	65·2	68·7	60·0	69·2	64·9	55·1	15·6	22·6	30·6

Figures are regional industry shares of national industry employment in percentage terms.
Source: Garza (1985), INEGI *Industrial Census*, various years.

The opening to trade has coincided with the decline of Mexico City's role in the economy and the rise of the Border as an industry centre. Table 2 shows that between 1980 and 1988 Mexico City's share of national manufacturing employment fell from 44·4% to 33·2%, while the Border's share increased from 21·0% to 28·2%. In Table 2 it is evident that the shift out of Mexico City has been concentrated in the footloose industries that led to the city's initial emergence as an industry centre – textiles, chemicals, and metal products. Table 2 shows that the largest increases in the Border's manufacturing employment share have been in textiles and metal products, the two industries that account for most maquiladora production. Given high levels of foreign ownership in maquiladoras, this suggests that the relocation of economic

activity in Mexico has occurred through the exit of domestic firms in Mexico City and the entry of foreign firms in Border states.

Further evidence of a structural break is the change in the pattern of regional wage differentials. Table 3 shows regional average nominal wages relative to Mexico City average nominal wages by two-digit industry for 1980 and 1988. Between 1980 and 1988, wages in most Mexico City industries fell relative to those in other regions. Out of nine two-digit industries, wages in the Border and the Centre rose relative to Mexico City in seven industries, and wages in the North and the South rose relative to Mexico City in six industries.

Table 3
Regional Relative Wages, 1980–8

	Border		North		Centre		South	
Industry (ISIC)	1980	1988	1980	1988	1980	1988	1980	1988
Food products	0·776	0·882	0·604	0·625	0·630	0·730	0·544	0·630
Textiles, apparel	0·857	0·917	0·362	0·462	0·714	0·818	0·330	0·306
Wood products	0·729	0·905	0·536	0·602	0·518	0·507	0·424	0·480
Paper, printing	0·864	0·705	0·677	0·557	0·705	0·746	0·656	0·597
Chemicals	0·825	0·868	0·532	0·579	0·745	0·834	0·523	0·530
Non-metallic minerals	0·624	0·782	0·357	0·327	0·422	0·543	0·346	0·437
Basic metals	1·240	0·785	0·772	0·585	0·882	0·988	0·520	0·640
Metal products	0·743	0·812	0·441	0·505	0·692	0·723	0·373	0·348
Other industries	0·735	0·760	0·339	0·530	0·490	0·448	0·212	0·289

Figures are regional average wage/Mexico City average wage, by two-digit industry.
Source: Author's calculations with data from *Censo Industrial*, various years.

III. EMPIRICAL RESULTS

Conditional on Mexico City being the country's industry centre, the increasing-returns theory of agglomeration has two predictions: (1) regional relative wages are decreasing in transport costs from Mexico City and from the United States, and (2) trade reform causes a compression in regional wage differentials. Following equation (5), I estimate regional wages relative to Mexico City wages as a function of transport costs and trade policy.

III.A. *Empirical Specification*

Selecting the appropriate level at which to study regional relative wages requires some consideration. The theory is based on the maintained hypothesis that labour is mobile across regions. I study wages at the state level. While the city, and not the state, is in principle the appropriate unit of analysis, manufacturing employment in most states is concentrated in a single city. Mexico has 32 states. In the long run, we also expect labour to be mobile across industries. Over the intermediate time periods I consider, however, workers may face significant adjustment costs – from acquiring the requisite skills or

Table 4
Variable Means and Definitions

Variable	Definition	μ	σ	N
W_i/W_c	Average two-digit industry wage in state/ Average two-digit industry wage in Mexico City	0·648	0·347	1,567
MX	Distance in kilometers to Mexico City	816·8	647·3	31
US	Distance in kilometers to nearest United States border crossing	1,140·6	682·3	31

Observations on relative wages are for the time period 1965–88.

from union restrictions on industry hiring practices – in moving from one industry to another. Examining wages at too aggregate a level discards valuable information.

The approach I take is to study regional wage differentials at two levels of aggregation. The first level is the average state wage in two-digit (ISIC) manufacturing industries. The nine two-digit industries in the sample represent relatively broad categories of industrial activity (see Table 1). The regression equation for the first specification is

$$\ln\left(\frac{w_{ijt}}{w_{cjt}}\right) = \beta_0 + \beta_1 \ln MX_i + \beta_2 \ln US_i + \delta_t \theta \ln MX_i + \delta_t \phi \ln US_i + \epsilon_{ijt}, \quad (6)$$

where w_{ijt} is the average nominal wage for two-digit industry j in state i at time t, w_{cjt} is the average nominal Mexico City wage in industry j at time t, MX_i is unit transport costs from state i to Mexico City, US_i is unit transport costs from state i to the United States, δ_t is a dummy variable that takes a value of one if year t falls after the date of trade liberalisation, and ϵ_{ijt} is an error term whose structure I discuss below. The predictions are that β_1 and β_2 are negative and that trade reform causes a structural break in the relationship between relative wages and transport costs. In particular, the effect of transport costs to Mexico City should fall after trade reform. To test the second prediction, I check whether the regression equation is stable over time, which is equivalent to the joint test that θ and ϕ are equal to zero.

If labour is mobile across two-digit industries, then observations on different industries in the same state will not be independent. To control for this possibility, I estimate a second specification in which I use observations on aggregate state manufacturing industries. The dependent variable becomes $\ln(w_{it}/w_{ct})$, the average state manufacturing wage in state i relative to the average state manufacturing wage in Mexico City. The regressors remain the same. One disadvantage of using state-level data, as opposed to state-industry-level data, is that I am unable to control for inter-industry wage differentials, which, given industries are not uniformly distributed across regions, may create artificial differences in wages across states.

Table 4 describes the regression variables. Wages are calculated as total remuneration per worker, using data from the 1965, 1970, 1975, 1980, 1985

and 1988 Mexico *Industrial Census*. The measures of transport costs I use are distance from a state's largest city to Mexico City (*MX*) and to the nearest major United States border crossing (*US*).

A further issue is that special enterprise zones along the United States border in effect liberalised trade for Mexican border states prior to the rest of the country. Border maquiladoras were already producing for export at the time of trade reform. Wages in border states may reflect the region's privileged access to foreign capital and foreign markets. To control for this possibility, I allow regression coefficients for border states to differ from those for interior states.

III.B. *Estimation Issues*

I allow idiosyncratic components, such as exogenous natural-resource supplies and amenities, to affect regional relative wages by taking a fixed-effects approach to estimating equation (6). I assume the error term ϵ_{ijt} has the following form:

$$\epsilon_{ijt} = \omega_i + \kappa_j + \nu_t + \eta_{ijt}, \tag{7}$$

where ω_i is the fixed effect for state i, κ_j is the fixed effect for industry j, ν_t is the fixed effect for year t, and η_{ijt} is an i.i.d. term with mean zero and variance σ. The fixed-effects assumption is warranted by the fact that my sample includes all Mexican states and industries (Greene, 1993).

Fixed-effects estimation presents a problem. In equation (6) the distance variables I use to measure transport costs vary across states but not across industries or years. First-differencing the data would eliminate the distance variables from the regression and using state dummy variables to capture fixed state effects would introduce perfect multicollinearity. I first estimate equation (6) with industry and year dummies in the regression. The distance variables, in addition to capturing transport costs, will pick up any other state effects that are correlated with distance. The question of interest is what portion of fixed state effects are associated with distance to industry centres. I perform a second regression in which I replace distance variables with state dummy variables. The estimated state fixed effects are the mean effect of state characteristics on relative wages, controlling for year and industry. To determine the relative importance of distance among other state attributes, I regress the estimated state fixed effects on the distance variables. To the extent that the distance variables explain a large portion of the variance in the estimated state fixed effects, I am led to believe that distance is an important state characteristic for relative wages.[4]

Once I know the portion of fixed state effects that are related to distance to Mexico City and to the United States, I am still left to argue that distance reflects transport costs and not other state characteristics. The alternative hypotheses outlined in Section I concern (i) exogenous natural-resource supplies, (ii) exogenous levels of amenities, and (iii) location bias in government

[4] I do not perform a similar procedure on state-level data, as I only have six observations per state (as opposed to 54 observations per state in the state-industry-level data), which is insufficient to estimate state fixed effects.

spending or tax policies. For exogenous natural-resource supplies to yield the same prediction for regional relative wages as equation (6), it must be true that natural resources are overwhelmingly concentrated in and around Mexico City and along the United States–Mexico border. The evidence presented in Section II suggests that this is not the case. For exogenous amenities to yield the same predictions as equation (6), it must be true that amenities increase with distance from Mexico City and from the United States. The available evidence suggests the opposite is in fact the case. For location bias in government policy to yield the same predictions as in (6), it must be true that government activities are concentrated in Mexico City or that Mexico City benefitted from subsidies or other government favours and that this location bias was eliminated or reduced at the time of trade liberalisation. While there is considerable evidence that government policy has favoured Mexico City (Garza, 1985), there is no clear evidence that the government eliminated this bias concomitant with the opening of the Mexican economy.

III.C. *Estimation Results*

Table 5 gives estimation results on equation (6). Observations are by two-digit industry and state over the time period 1965–88. All regressions report heteroskedasticity-consistent standard errors. The results show strong support for the hypothesis that relative wages decline with distance from industry centres. Both distance variables are, as predicted, negative and statistically significant at the 1% level in all regressions. Moreover, the estimated quantitative effects of distance on relative wages are substantial. From column (2*a*), a 10% increase in distance from Mexico City leads to a 1·92% decrease in the relative state nominal wage, and a 10% increase in distance from the United States–Mexico border leads to a 1·28% decrease in the relative state nominal wage.

To test whether trade liberalisation has compressed regional wage differentials, I interact the distance variables with a dummy variable that takes a value of one if the year is after 1985, the year in which trade reform was implemented. Columns (1*b*) and (2*b*) in Table 5 show the results. I find evidence neither of a structural break in the relationship between distance and regional relative wages, in general, nor of a decrease in the effect of distance from Mexico City, in particular. In both regressions I fail to reject the null hypothesis that the trade reform–interaction terms are zero. Hence, I find little evidence that trade reform affected regional relative wages over the sample period.

There is other evidence of a compression in regional wage differentials. Coefficient estimates on the yearly intercept terms are all positive and tend to increase over time. The excluded year is the first year of the sample, 1965, which suggests that, holding distance from Mexico City and the United States constant, state wages have been increasing relative to Mexico City wages. Intercept terms for all years after 1970 are both positive and, in most cases, statistically significant. Thus, while there has been a compression in regional wage differentials, it began well before the implementation of trade reform.

Table 5

Regression Results for Two-Digit State Industries

(Heteroskedasticity-consistent standard errors in parentheses)

Variable	(1*a*)	(1*b*)	(2*a*)	(2*b*)	(3)
ln *MX*	−0·143**	−0·133**	−0·192**	−0·181**	—
	(0·013)	(0·015)	(0·014)	(0·012)	
ln *US*	−0·151**	−0·151**	−0·128**	−0·129**	—
	(0·011)	(0·012)	(0·047)	(0·050)	
ln *MX TR*	—	−0·059	—	0·064	—
		(0·035)		(0·038)	
ln *US TR*	—	0·005	—	0·010	—
		(0·030)		(0·091)	
ln *MX BD*	—	—	0·278**	0·279**	—
			(0·041)	(0·043)	
ln *US BD*	—	—	0·158**	0·153**	—
			(0·049)	(0·051)	
ln *MX BD TR*	—	—	—	−0·008	—
				(0·087)	
ln *US BD TR*	—	—	—	0·025	—
				(0·086)	
*YR*70	0·073	0·073	0·075	0·075	0·079
	(0·051)	(0·051)	(0·049	(0·049)	(0·042)
*YR*75	0·141**	0·142**	0·143**	0·144**	0·145**
	(0·052)	(0·052)	(0·060)	(0·050)	(0·042)
*YR*80	0·218**	0·219**	0·218**	0·218**	0·223**
	(0·050)	(0·050)	(0·048)	(0·048)	(0·042)
*YR*85	0·270**	0·270**	0·271**	0·271**	0·276**
	(0·049)	(0·049)	(0·047)	(0·047)	(0·042)
*YR*88	0·217**	0·550	0·220**	0·548	0·233**
	(0·052)	(0·357)	(0·050)	(0·621)	(0·042)
F-statistic on *TR* interaction terms	—	2·06	—	1·45	—
F-statistic on *BD* interaction terms	—	—	92·54**	55·47**	—
F-statistic on *YR*70–*YR*88 terms	8·60**	8·24**	9·30**	8·72**	12·41**
Adjusted R^2	0·177	0·178	0·239	0·239	0·408
N	1,567	1,567	1,567	1,567	1,567

* (**) indicates statistical significance at the 5% (1%) level. *BD* is a dummy variable indicating border states. *TR* is a dummy variable indicating the year is after 1985 (when trade reform was initiated). *YR*70 is a dummy variable indicating the year is 1970, etc. All regressions include dummy variables for two-digit industries. Column (3) includes state dummy variables. For expositional ease, I do not report coefficient estimates on the constant term, the border intercept term, or industry or state dummy variables.

Reductions in transport costs or changes in government policy could explain the general tendency of wage compression.

The reduction of tariffs and import licences was not the only component of Mexico's liberalisation efforts. The maquiladora programme, which opened border states to foreign trade and investment, was an important first step in opening the rest of the economy. To test whether the maquiladora programme affected regional wage differentials, I allow the effects of distance on relative wages to differ between border and interior states by interacting the distance

variables with a dummy variable for border states. Columns (2*a*) and (2*b*) of Table 5 show the results. In both regressions I reject the null hypothesis that coefficient estimates for border and interior states are at the same at the 1% level. The positive coefficient estimates on the border interaction terms indicate that for border states distance from Mexico City and from the United States have smaller effects on wages. This is consistent with the hypothesis that the maquiladora programme gave firms in border states relatively low-cost access to foreign markets and foreign capital, making them less reliant on closed-economy industry centres.

To check the robustness of the regression results, I replace distance variables with state dummy variables and re-estimate equation (6). Column (3) of Table 5 shows the results. The adjusted R^2 increases from 0·239 to 0·408, which suggests, not surprisingly, that there are other state-specific characteristics that matter for relative wages. To pursue the issue further, I regress the estimated state dummies on the distance variables:

$$\omega_i^{ols} = \underset{(0\cdot89)}{2\cdot83} - \underset{(0\cdot05)}{0\cdot17}\ln MX_i - \underset{(0\cdot13)}{0\cdot14}\ln US_i - \underset{(0\cdot14)}{0\cdot06}\ln MX_i BD + \underset{(0\cdot14)}{0\cdot14}\ln US_i BD,$$

$$\bar{R}^2 = 0\cdot464,\ N = 30,$$

where ω_i^{ols} is the estimated state effect for state i and BD is a dummy variable for border states. That distance explains 46·4% of the variance in fixed state effects suggests that transport costs, as measured by distance, are an important characteristic of states for relative wages.

As a further robustness check, I estimate the effects of distance on relative wages using observations on aggregate state manufacturing industries. The dependent variable is the average state manufacturing wage relative to the average Mexico City manufacturing wage. The time period is again 1965–88. Table 6 reports the coefficient estimates. The results are generally consistent with those in Table 5. I again find strong evidence that relative wages are decreasing in distance to Mexico City. Ln *MX* is negative and statistically significant at the 1% level in all regressions. Results on distance to the United States are somewhat weaker. Ln *US* is negative and statistically significant in the two regressions which do not include border controls, but the variable is positive and statistically insignificant in the two regressions with border controls. Similar to the results in Table 5, I again find (1) no evidence of a structural break in the relationship between distance and relative wages after trade reform, (2) strong evidence of a falling regional wage differentials over time, and (3) strong evidence that distance effects differ between border and interior states.

Overall, I find strong evidence that regional nominal wages are positively correlated with proximity to industry centres. This accords with the descriptive analysis of Section II: the states with the highest wages were those located near Mexico City or along the United States–Mexico border; the states with the lowest wages were those proximate to neither the capital nor the United States market. There is weaker evidence of a compression in regional wage differentials following trade reform. I do find that regional wage differentials

Table 6

Regression Results for State Manufacturing Industries

(Heteroskedasticity-consistent standard errors in parentheses)

Variable	(1*a*)	(1*b*)	(2*a*)	(2*b*)
ln *MX*	−0·151**	−0·147**	−0·206**	−0·202**
	(0·016)	(0·018)	(0·022)	(0·025)
ln *US*	−0·106**	−0·108**	0·111	0·111
	(0·016)	(0·018)	(0·099)	(0·106)
ln *MX TR*	—	−0·025	—	−0·023
		(0·035)		(0·051)
ln *US TR*	—	0·010	—	0·004
		(0·033)		(0·174)
ln *MX BD*	—	—	0·059	0·060
			(0·072)	(0·082)
ln *US BD*	—	—	−0·086	−0·087
			(0·101)	(0·109)
ln *MX BD TR*	—	—	—	−0·005
				(0·174)
ln *US BD TR*	—	—	—	0·002
				(0·165)
*YR*70	0·012	0·012	0·012	0·012
	(0·097)	(0·097)	(0·098)	(0·098)
*YR*75	0·118	0·118	0·118	0·118
	(0·097)	(0·097)	(0·088)	(0·088)
*YR*80	0·235*	0·235*	0·235**	0·235**
	(0·093)	(0·093)	(0·085)	(0·085)
*YR*85	0·259**	0·259**	0·259**	0·259**
	(0·085)	(0·085)	(0·078)	(0·078)
*YR*88	0·281**	0·373	0·281**	0·407
	(0·091)	(0·353)	(0·083)	(1·106)
F-statistic on *TR* interaction terms	—	0·38	—	0·15
F-statistic on *BD* interaction terms	—	—	18·31**	14·34**
F-statistic on *YR*70–*YR*88 terms	4·14**	3·39**	4·92**	3·90**
Adjusted R^2	0·255	0·248	0·363	0·349
N	186	186	186	186

* (**) Indicates statistical significance at the 5% (1%) level. *BD* is a dummy variable indicating border states. *TR* is a dummy variable indicating the year is after 1985 (when trade reform was initiated). *YR*70 is a dummy variable indicating the year is 1970, etc. For expositional ease, I do not report coefficient estimates on the constant term or the border intercept term.

have fallen over time, but this process began well before trade liberalisation. One factor which might account for this result is difficulty in dating the implementation of trade reform. While the general liberalisation of trade began abruptly in 1985, the maquiladora programme represented a more gradual process of economic opening. My finding that distance to industry centres matters less for border states is consistent with the idea that the maquiladora programme was an important component in Mexico's opening to trade. This suggests that inflows of foreign capital have had at least as large an effect on regional wage differentials as the actual lowering of trade barriers.

The empirical results are consistent with two motivations for industry agglomeration: increasing returns to scale in production and location bias in government policy. While the results cannot distinguish between these two explanations, it is important to emphasise that they are not mutually exclusive. Indeed, they are in many respects complementary. Prior to Mexico's industrialisation, location bias in government policy helped establish Mexico City as a major political and commercial centre. Given increasing returns, industry would be naturally attracted to such a large urban population mass. Industrial concentration in Mexico City would then increase the demand for subsidies or public spending that favour local producers, thereby exacerbating the location bias in policy. There are limits to this story, however. Policy bias in favour of Mexico City cannot account for the northward shift in economic activity following trade reform. This aspect of Mexico's regional economic development ascribes a large role to transport costs, and, perhaps, increasing returns to scale in determining industry location.

IV. CONCLUDING REMARKS

This paper examines the structure of regional relative wages in Mexico before and after trade reform. I find that distance from industry centres matters for regional relative wages: nominal wages are highest near the industry centres in Mexico City and the United States–Mexico border. The results are consistent with some combination of increasing returns to scale in production and location bias in government policy. The importance of market access for relative wages highlights the role of trade policy in regional development. However, unintended it may have been, import substitution contributed to the creation of such metropolises as Mexico City. In a perhaps equally unintended manner, the opening of developing economies to foreign trade and investment appears to undermine the economic rationale of such megacities.

A striking feature of the empirical results is that, while Mexico's economic opening has contributed to the deconcentration of economic activity in Mexico City, some policies appear to have had larger effects than others. I find that special enterprise zones located along the United States–Mexico border have done more to compress regional wage differentials than the overall reduction of tariffs and quotas. That foreign-owned firms account for most economic activity in Mexico's special enterprise zones suggests that foreign investment has played an important role in the relocation of economic activity from Mexico City to the United States–Mexico border region. This is consistent with Rivera-Batiz and Rivera-Batiz (1990), who show that foreign capital inflows, by increasing the degree of specialisation in production, can have large effects on the location of domestic firms. It is important to note the data in my sample cover only the first three years of trade reform and do not capture the full effects of adjustment. More importantly, the North American Free Trade Agreement extends Mexico's trade reform by further lowering trade barriers between Mexico, the United States, and Canada. My findings suggest that, as North American economic integration proceeds, the United States–Mexico border

region will continue to draw resources from other regions in Mexico, further diminishing the role of Mexico City in the nation's economy.

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